OMI Validation Needs

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(on behalf of the OMI validation team)

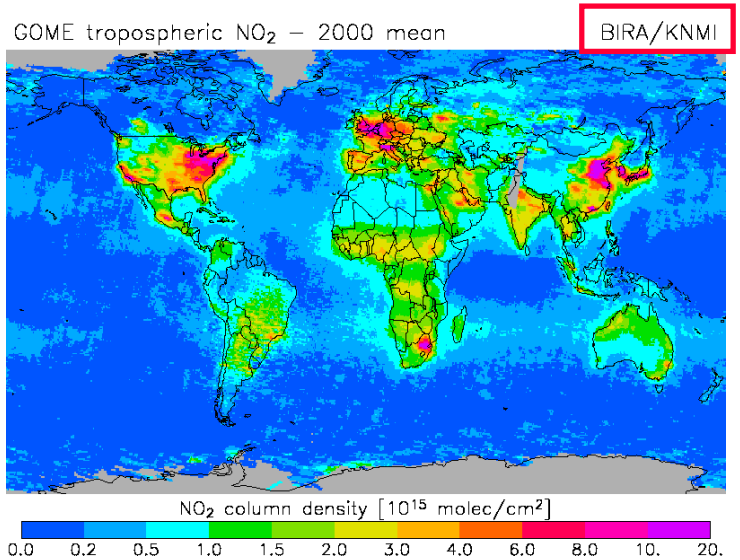
Aura Science Team Meeting
Aura Validation Working Group

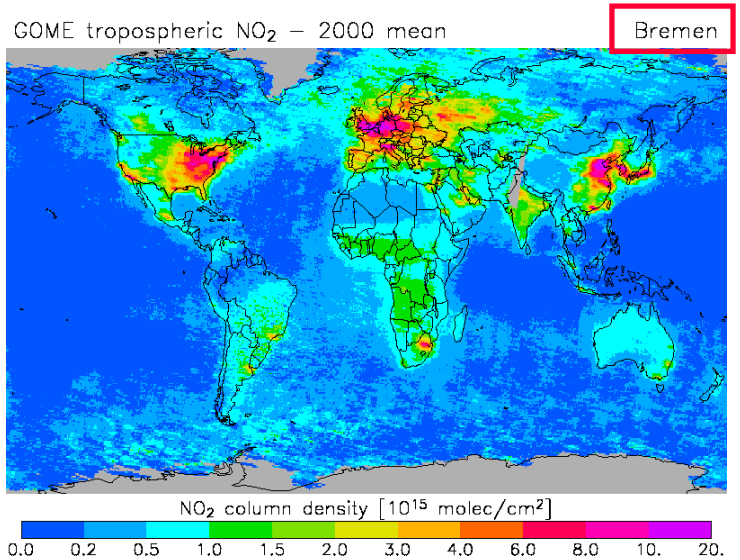
Pasadena, CA, USA
01 October 2007

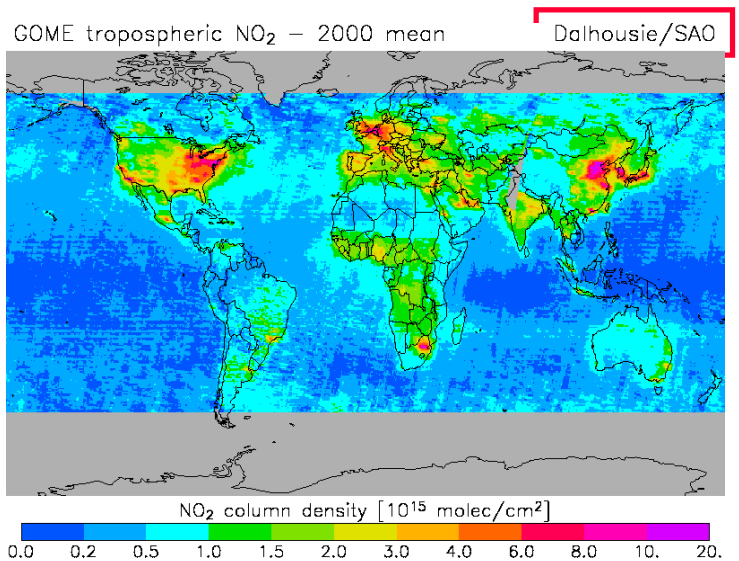
OMI Validation Priorities

- **Nitrogen Dioxide (NO2)**
  - Air quality, emission estimates, sparse correlative data
- **Ozone (O3)**
  - Air quality, human health hazard, ozone (hole) recovery, remaining retrieval challenges (tot-O3C, trop-O3C)
- **Aerosols**
  - Air quality, retrieval challenges, physics of aerosols
- **Sulphur Dioxide (SO2)**
  - Air quality, emission estimates, aviation warning
- **Clouds**
  - Influence to (tropospheric) trace gas retrievals
- **"Minor" trace gases (BrO, OClO, HCHO, CHO-CHO)**
  - Shortage of correlative data in general

GOME tropospheric NO_2 intercomparison





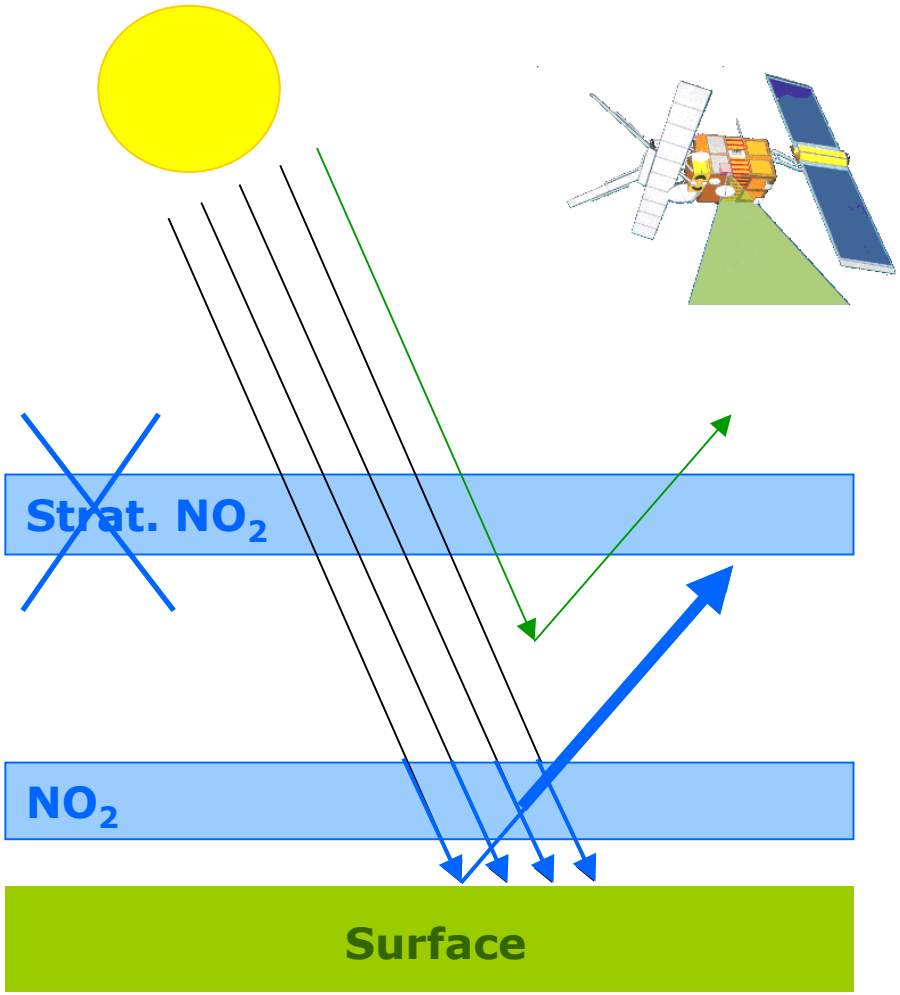


Why such differences?

Who is right?

Van Noije et al., ACP, 2006

The 3 steps to tropospheric NO_2 VCDs



STEP 1: DOAS → NO_2 SCD

STEP 2:

Remove the stratospheric part → tropospheric NO_2 (TSCD)

STEP 3:

Convert TSCD into tropospheric VCD_{NO2}

$$VCD_{NO_2} = \frac{TSCD}{AMF}$$

Examples of solutions currently in use

Property	Current treatment in AMF calculation	Groups
Surface albedo	- GOME/TOMS data base	All groups
Cloud fraction and cloud top height	- Screening based on cloud fraction - Explicit correction using IPA and accounting for ghost column	- Bremen, Heid - KNMI, NASA, SAO
NO_2 profiles	- Scenarios - Monthly mean profiles (MOZART) - Daily profiles (GEOS-CHEM) - Daily profiles (TM4)	- Heid, NASA - Bremen - SAO - KNMI
Aerosols	- Neglected - Scenarios (Lowtran) - Implicitly corrected by cloud treatment - Complex aerosol model	- Heid - Bremen - KNMI, NASA - SAO

Nitrogen Dioxide (1)

Retrieval Challenges

- Most retrievals calculate same Slant Column Density
- Air Mass Factor calculation differs by research group
- Different versions of column NO2 and trop. NO2 (level 1B publ.)

Need for validating retrieval input and satellite output data

- NO2 profiles in polluted regions, NO2 diurnal cycle
- Cloud fraction and cloud height (related issue)
- Total / tropospheric NO2 columns in polluted regions

Campaigns versus Networks

- DANDELIONS-1 and 2 have proven relevance of observations
- Need for network in polluted regions providing continuity

Ground-based NO_2 measuring instruments

Chemiluminescent NO_x analyzer

DOAS, LIF, TILDAS, LIDAR
(research grade instruments)

Molybdenum converter

- Commonly used instrument
- Specific to NO
- **Indirect measurement of NO_2**
- Significant interference from other reactive nitrogen compounds

Photolytic converter

- Specific to NO_2
- Some interference from HONO
- Not widely available

Interference in molybdenum converter analyzer

Compounds	Conversion efficiency	Experiments
NO_2, ethylnitrate (C2H5NO3)	~ 100%	*Winer et al., 1974*
PAN (Peroxyacytyl nitrate)	92%	*Winer et al., 1974*
HNO_3, PAN, n-propyl nitrate, n-butyl nitrate	≥98%	*Grosjean and Harrison, 1985*
Ammonia, gas phase olefins, particulate nitrate	No significant interference	*Dunlea et al., 2007*

Difficult issue: Loss of HNO_3 on stainless steel of inlet
Difficult to quantify the conversion efficiency

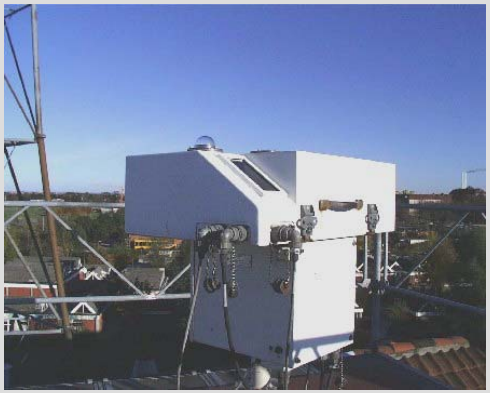
Nitrogen Dioxide (2)

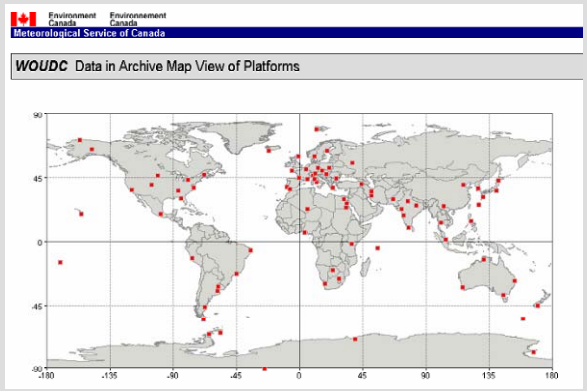
Ground Truth

- Molybdenum systems measure more than NO2
- Most NO2 specific systems are “research grade”
- NO2 lidar systems are expensive

“A Brewer/Dobson”-like network for NO2

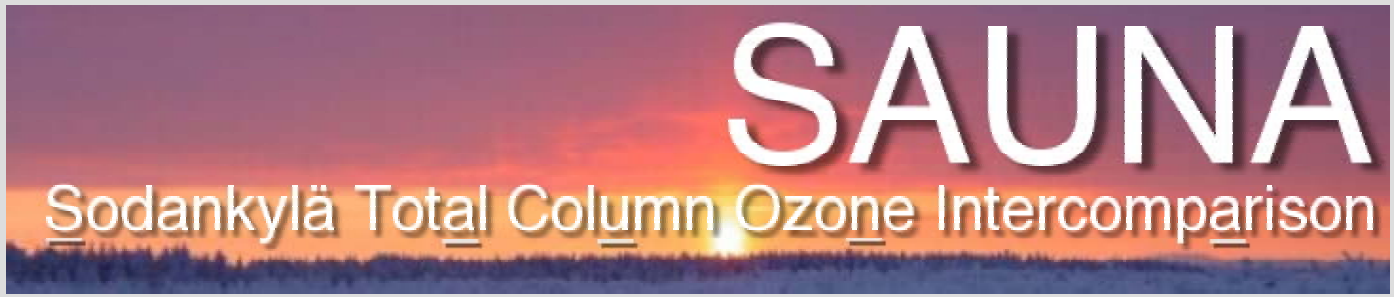
- Reference network of observations providing continuity
- SAOZ/DOAS network at sunrise and sunset insufficient (model)
- Pandora, direct sun, (mini)MAX-DOAS, in-situ, Double Brewer





Total Ozone Column

- OMI retrievals at high SZA remain challenging (e.g. OMI-TOMS)
- Same holds for ground based observations (e.g. single Brewer)
- SAUNA-I and SAUNA-II may provide answers
- If not sufficient a SAUNA –III is needed



- Cloud height influence identified (climatology vs O2-O2)
- Need for analysis TC-4 data (lidar, CAFS)
- If not sufficient need for more campaign data

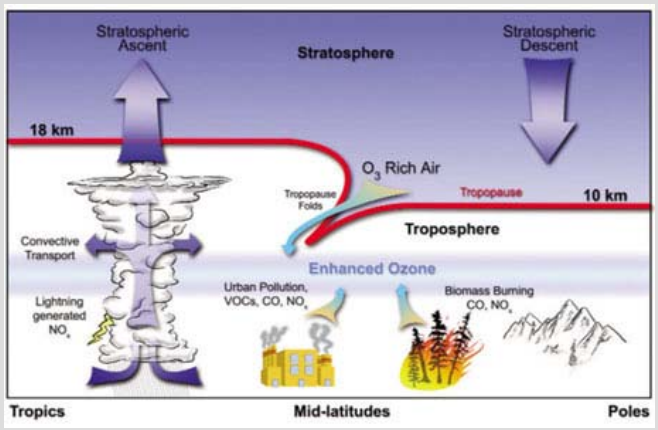
Tropospheric Ozone Column

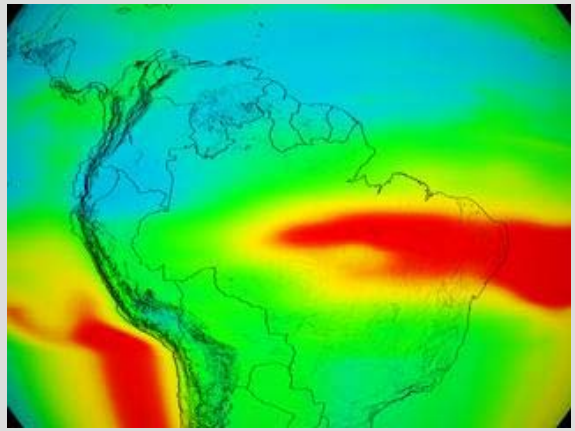
Strong interest from Air Quality perspective

- Air quality constituent, respiratory illnesses
- Obtained from OMI-MLS and other techniques (e.g. Schoeberl)
- ~10% of total column, 1%*300DU=3DU=10% of trop

Campaigns versus Networks

- Aircraft in-situ/remote sensing in polluted regions
- (tethered) Balloons and Ozone lidars in polluted regions
- Ground truth with (mini) MAX-DOAS





Aerosols

Retrieval Issues

- Retrievals use auxiliary data (surface albedo, aerosol microphysical properties, wind speed, etc.)
- Retrievals themselves are accurate ($\chi 2$), outcome does not correlate well with Aeronet or Sat-Sat (MODIS, PARASOL)

Validation of auxiliary data

- Aerosol microphysical properties, global distributions of aerosols (e.g. type), layer altitudes, transport
- Airborne campaigns flying PALMS-like systems (e.g. type)

Results of OMAERO-MODIS Comparisons

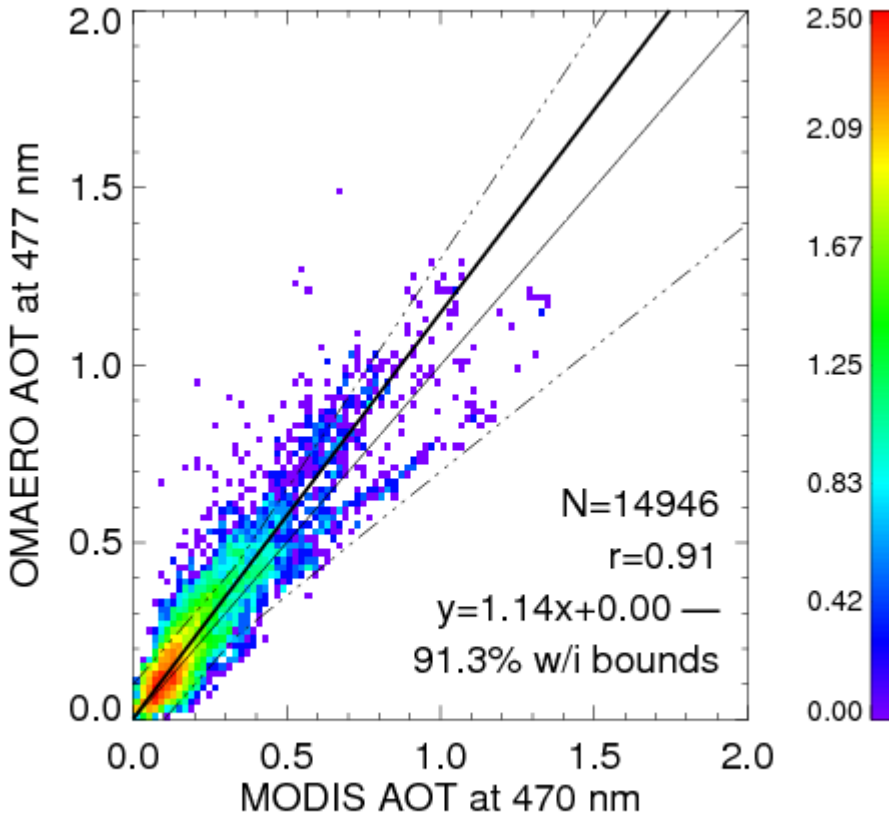
1-21 June 2006

Oceans worldwide

No sunglint

ALL collocations (regardless of OMI/MODIS coverage and MODIS QA)

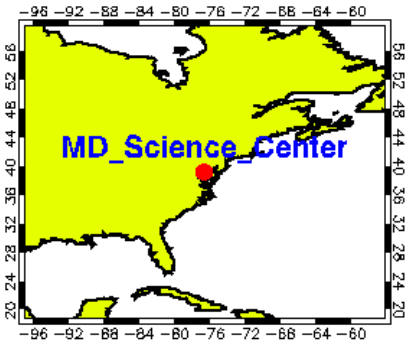
Only pixels completely covered by sufficiently cloud-free and quality-assured MODIS pixels



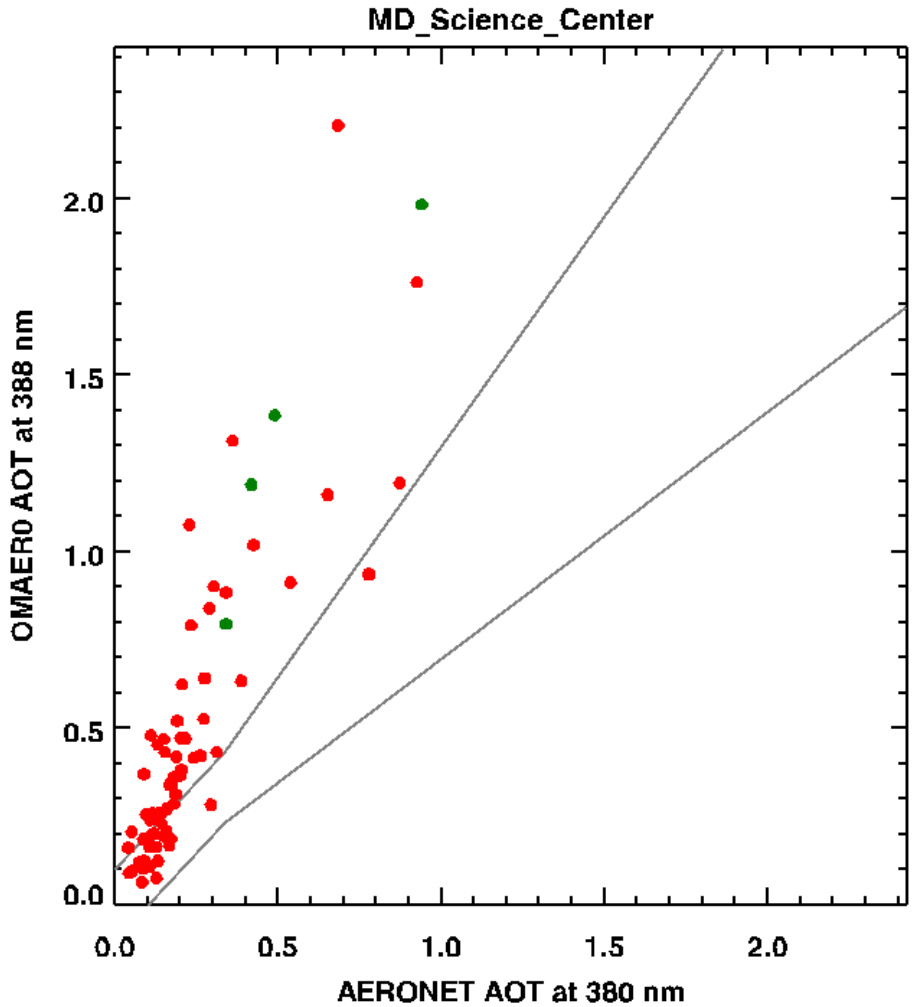
Good agreement with quality-assured MODIS AOT

AERONET Comparison Examples – 2005

MD Science Center ***OMAERO tends to overestimate over land***



Lat: 39.3 deg
Lon: -76.6 deg
Alt: 15.0 m



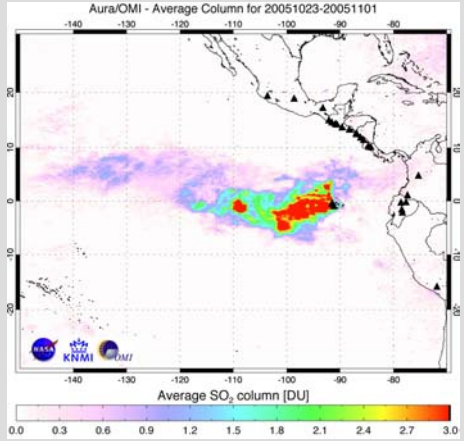
- Weakly absorbing
- Biomass burning
- Desert dust

r = 0.88

Sulphur Dioxide (SO2)

Retrieval issues

- Depends on height of layer, profile and aerosols



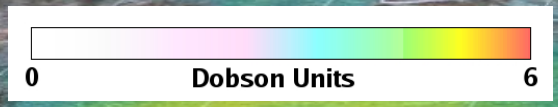
In situ SO2 observations from aircraft

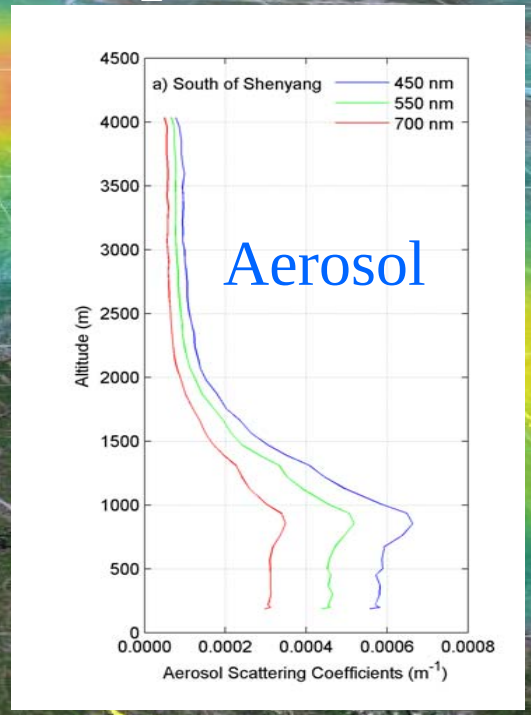
- near volcanoes for plume characterization
- areas of high SO2 pollution (China, East Europe)
- Importance of aircraft profiling of SO2 in PBL
- simultaneous measurements of aerosol type (dust vs sulfate or soot) and SO2 profiles.

Ground based column SO2 measurements

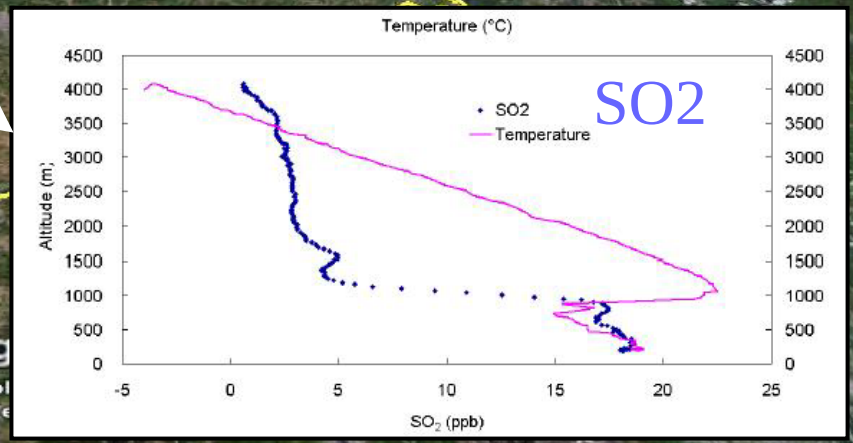
- double Brewer instruments (not single Brewers)
- (MAX)-DOAS type systems
- need for advanced Brewer SO2 algorithm

First validation during EAST-AIRE regional experiment over NE China in April 2005. SO_2 observations from instrumented aircraft flights are compared with OMI SO_2 maps.





Aircraft spirals



Shenyang
Fushun
Anshan
Dandong
N43°
N41°
© 2006 Europa Technol
Image © 2006 TerraMe

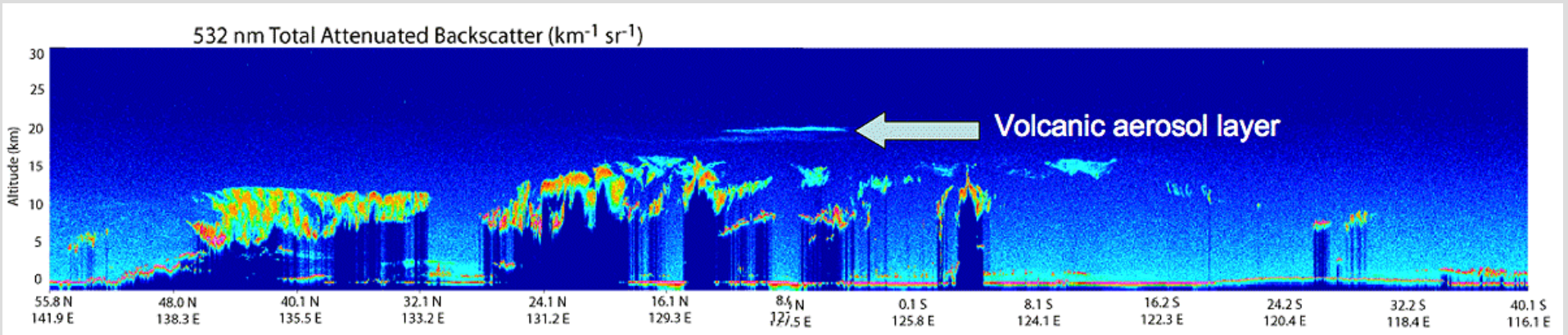
Clouds

Clouds and Retrievals

- Cloud height (UV-VIS-IR) and Cloud fraction (model dep.)
- Both influence trace gas retrievals, particularly tropospheric column estimates but also total ozone column (e.g. OMI-TOMS)

Validation

- Sat-Sat is upcoming (e.g. MODIS, Parasol, CloudSat, Calipso)
- TC-4 data will help to validate / evaluate OMI data
- Ground radar/lidar for PBL and cloud height



Collection 3 Retrievals: Outlook

- Standard Data Products: HCHO, BrO, HCHO
  - Check with validation sources
  - Fine-tune fitting window
  - Optimize smoothing
  - Take a closer look at Spatial Zoom Da
- Science Data Products: CH , IO
  - Glyoxal: migration to C pending
  - Iodine Monoxide: et, but we keep looking
- Time Fram
  - Sta products: Delivery of new version 1.1.0 in time for er to L1b Collection 3 to forward (Summer 2007)
    nd complete reprocessing with v1.1.0
    Science data products: Migration will proceed in parallel with update of standard products

From : Thomas Kurosu, "Other Trace Gases (a.k.a. HCHO, BrO, and OClO) Status & Outlook", OSTM Baltimore 2007